JOURNAL OF

THE GEOLOGICAL SOCIETY

Volume 147 1990

Chief Editor: Dr M. J. Le Bas.

Editors: Dr J. R. Andrews, Dr D. Barr, Dr K. H. Brodie, Dr B. Chadwick, Dr H. Colley, Dr I. J. Fairchild, Dr N. B. W. Harris, Dr R. J. Pankhurst, Dr K. T. Pickering, Dr R. A. Scrutton, Dr Derek J. Siveter, Dr N. J. Soper, Dr Derek J. Siveter, Dr N. J. Soper, Dr J. R. Underhill, Dr P. J. Williams.

Advisory Editors: Dr J. D. Bell, Professor F. W. Cambray, Dr L. R. M. Cocks, Professor I. W. D. Dalziel, Dr L. E. Frostick, Dr P. L. Hancock, Dr R. T. Haworth, Dr J. D. Hudson, Mr A. Notholt, Dr D. Robinson, Professor A. Taira, Dr W. E. G. Taylor, Dr P. A. Ziegler.

150 years ago, The Geological Society witnessed the inception of the Glacial Theory and demise of the Diluvial Theory.

Nov.4. [1840]: A paper was read on Glaciers, and the evidence of their having once existed in Scotland, Ireland, and England, by Professor Agassiz, of Neuchatel . . . If the analogy . . . with those in Switzerland, be correct . . . not only glaciers once existed in the British Islands, but that large sheets (nappes) of ice covered all . . .

Nov. 18: A memoir on the Evidences of Glaciers in Scotland and the North of England, by the Rev. Prof. Buckland, D.D., Pres.G.S., commenced on the 4th November, was resumed and concluded.

A paper "On the geological evidence of the former existence of Glaciers in Forfarshire," by Charles Lyell, jun., Esq., F.R.S., F.G.S., was commenced.

[Geological Society of London, Proceedings III, 327–337].

In the discussion that followed:

Mr. Murchison called on the mathematicians and physical geographers present to speak of the objections to Dr. Buckland's glacial hypothesis. . . . Mr. Greenough . . . objected . . . referred to the changes in climate necessary . . . the climax of absurdity in geological opinions. Dr. Buckland . . . argued a priori credit [for] his narrative. . . . he went and saw all these things . . . in the Alps . . . and condemned the tone in which Mr. Murchison had spoken. . . . Mr. [Charles] Darwin has described an island capped in snow in the equivalent latitude of Yorkshire . . . and, amidst the cheers of the delighted assembly, who were by this time elevated by the hopes of soon getting some tea (it was a quarter to twelve p.m.) and excited by the critical acumen . . . by the learned Doctor. . . . [he] concluded with a look and tone of triumph . . .

[Report on the meeting in The Midland Naturalist, 1883, VI, 225–229].

1991

THE GEOLOGICAL SOCIETY

BURLINGTON HOUSE

PICCADILLY

LONDON W1V 0JU

Compiled by Dr C. J. Burton

Journal published and distributed by GEOLOGICAL SOCIETY PUBLISHING HOUSE, Unit 7,
Brassmill Enterprise Centre, Brassmill Lane,
Bath BA1 3JN

Printed in Northern Ireland at THE UNIVERSITIES PRESS (BELFAST) LTD.
Alanbrooke Road, Belfast BT6 9HF

© GEOLOGICAL SOCIETY OF LONDON 1991

Dates of issue of Volume 146

Part 1 (for January):	pages 1–208	15 December 1989
Part 2 (for March):	pages 209–416	16 February 1990
Part 3 (for May):	pages 417–576	12 April 1990
Part 4 (for July):	pages 577–734	15 June 1990
Part 5 (for September):	pages 735–894	14 August 1990
Part 6 (for November):	pages 895–1100	15 October 1990

CONTENTS

page

AITCHESON, S.J. Nd isotopic evidence for exotic detritus in the Kalak Nappe Complex, north Norwegian Caledonides 923
AL-BIATTY, H. *See* LEEDER, M.
ALABASTER, T. & STOREY, B.C. Antarctic Peninsula continental magnesian andesites: indicators of ridge–trench interaction during Gondwana break-up 595
ALEXANDER, J. & LEEDER, M.R. Geomorphology and surface tilting in an active extensional basin, Sw Montana, USA 461
ALLEN, J.R.L. Constraints on measurement of sea-level movements from salt-marsh accretion rates 5
____ The formation of coastal peat marshes under an upward tendency of relative sea-level 743
ALONSO ZARZA, A.M. *See* WRIGHT, V.P.
ANDERSEN, T.B., Skjerlie, K.P. & Furnes, H. The Sunnfjord Melange, evidence of Silurian ophiolite accretion in the West Norwegian caledonides 59
ANDERSON, E.J. & GOODWIN, P.W. The significance of metre-scale allocycles in the quest for a fundamental stratigraphic unit 507
ASTIN, T.R. The Devonian lacustrine sediments of Orkney, Scotland; implications for climatic cyclicity, basin structure and maturation history 141
AUDLEY-CHARLES, M.G. *See* HARBURY, N.A.

BADLEY, M.E. *See* ROBERTS, A.M.
BAILEY, D.K. *See* NGWENYA, B.T.
BAKKEN, B. *See* MARTINSEN, O.J.
BARBER, A.J. *See* MAX, M.D.
BARRON, E.J. *See* HAY, W.W.
BASSETT, M.G., SIVETER, D.J. & COCKS, L.R.M. Introduction: The Murchison Symposium 653
BATES, D.E.B. Retiolite nomenclature and relationships 717
BELL, A. *See* DIMBERLINE, A.J.
BENNETT, M.C. *See* SLOAN, R.J.
BENTLEY, M.R. *See* FITCHES, W.R.
BERHE, S.M. Ophiolites in Northeast and East Africa: implications for Proterozoic crustal growth 41
BERNOULLI, G.A. *See* FRÜH-GREEN, G.
BLUNDELL, D.J. *Presidential address*: Seismic images of continental lithosphere 895
BOND, M. *See* MCELROY, R.
BORYTA, M. & CONDIE, K.C. Geochemistry and origin of the Archaean Beit bridge complex, Limpopo Belt, South Africa 229
BRANNEY, M.J. & SPARKS, R.S.J. Fiamme formed by diagenesis and burial-compaction in soils and subaqueous sediments 919
BROWN, P.E. *See* FINCH, A.A.
BRYANT, I.D. & SMITH, M.P. A composite tectonic-eustatic origin for shelf sandstone at the Cambrian–Ordovician boundary in North Greenland 795
BURNARD, P. *See* THIRLWALL, M.F.

CARLIER, G. *See* JAILLARD, E.
CASSEDAY, R.P. *See* DOIG, R.
CATER, J. *See* MCELROY, R.
CHADWICK, B. The stratigraphy of a sheet of supracrustal rocks within high-grade orthogneisses and its bearing on Late Archaean structure in southern West Greenland 639
CHALONER, W.G. & CREBER, G.T. Do fossil plants give a climatic signal? 343
CHATTERTON, B.D.E., EDGECOMBE, G.D. & TUFFNELL, P,.A. Extinction and migration in Silurian trilobites and conodonts of northwestern Canada 703
CLIFT, P.D. & ROBERTSON, A.H.F. Deep-water basins within the Mesozoic carbonate platform of Argolis, Greece 825
CLOETINGH, S., GRADSTEIN, F.M., KOOI, H., GRANT, A.C. & KAMINSKI, M. Plate reorganization: a cause of rapid late Neogene subsidence and sedimentation around the North Atlantic 495
COCKS, L.R.M. *See* BASSETT, M.G.
COE, A.L. *See* HESSELBO, S.P.

COLLIER, R.E.LL. Eustatic and tectonic controls upon Quaternary coastal sedimentation in the Corinth Basin, Greece 301
CONDIE, K.C. *See* BORYTA, M.
COWARD, M.P. Shear zones at the Laxford front, NW Scotland and their significance in the interpretation of lower crustal structure 279
CRAMPIN, S. *See* LOVELL, J.H.
CREBER, G.T. *See* CHALONER, W.G.
CURTIS, C.D. Aspects of climatic influence on the clay mineralogy and geochemistry of soils, palaeosols and clastic sedimentary rocks 351

DALLMEYER, R.D. & GIL IBARGUCHI, J.I. Age of amphibolitic metamorphism in the ophiolitic unit of the Morais allochthon (Portugal): implications for early Hercynian orogenesis in the Iberian Massif 873
DARBYSHIRE,. D.P.F. *See* HARMS, U.
DÉGARDIN, J.M. The Silurian of the Pyrenees 687
DIMBERLINE, A.J., BELL, A. & WOODCOCK, N.H. A laminated hemipelagic facies from the Wenlock and Ludlow of the Welsh Basin 693
DIXON, P.R., LEHURAY, A.P. & RYE, D.M. Basement geology and tectonic evolution of Ireland as deduced from Pb isotopes 121
DOIG, R., NANCE, R.D., MURPHY, J.B. & CASSEDAY, R.P. Evidence for Silurian sinistral accretion of Avalon composite terrane in Canada 927
DONALDSON, C.H. *See* GREENWOOD, R.C.
DONATO, J.A. & MEGSON, J. A buried granite batholith beneath the East midland Shelf of the southern North Sea Basin 133
DROOP, G.T.R. *Conference Report:* Metamorphic studies: research in progress 561

EBDON, C.C., FRASER, A.J., HIGGINS, A.C., MITCHENER, B.C. & STRANK, A.R.E. The Dinantian stratigraphy of the East Midlands: a seismostratigraphic approach 519
EDGECOMBE, G.D. *See* CHATTERTON, B.D.E.
EDWARDS, D. *See* FANNING, U.
EMELEUS, C.H. *See* GREENWOOD, R.C.
ENGLAND, R.W. The identification of granitic diapirs 931

FALLICK, A.E. *See* SEARL, A.
FANNING, U. EDWARDS, D. & RICHARDSON, J.B. Further evidence for diversity in late Silurian land vegetation 725
FINCH, A.A., REAVY, R.J., HARRISON, T.M. & BROWN, P.E. Rapakivi granites, South Greenland: hydrothermal alteration of igneous layering 739
FITCHES, W.R., MUIR, R.J., MALTMAN, A.J. & BENTLEY, M.R. Is the Colonsay–west Islay block of Sw Scotland an allochthonous terrane? Evidence from Dalradian tillite clasts 417
FLINT, S. *See* JOLLEY, E.J.
FORTEY, R.A. & OWENS, R.M. Arenig biostratigraphy and correlation in the Welsh Basin 607
FRASER, A.J. *See* EBDON, C.C.
FREEMAN, B. *See* ROBERTS, A.
FRÜH-GREEN, G., WEISSERT, H. & BERNOULLI, D. A multiple fluid history recorded in Alpine ophiolites 959
FUNNELL, B.M. & OWEN, A.W. *Conference Report*: Palaeocomputing: keyboard to the past 393
FURNES, H. *See* ANDERSEN, T.B.

GIBSON, S.A. The geochemistry of the Trotternish sills, Isle of Skye: crustal contamination in the British Tertiary Volcanic Province 1071
GIL IBARGUCHI, J.I. *See* DALLMEYER, R.D.
GLENDINNING, N.R. *See* POWELL, D.
GLOVER, J.E. *See* RASMUSSEN, B.
GOODWIN, P.W. *See* ANDERSON, E.J.
GRADSTEIN, F.M. *See* CLOETINGH, S.
GRANT, A.C. *See* CLOETINGH, S.
GREENWOOD, R.C., DONALDSON, C.H. & EMELEUS, C.H. The contact zone of the Rhum ultrabasic intrusion: evidence of peridotite formation from magnesian magmas 209

HALLAM, A. Correlation of the Triassic–Jurassic boundary in England and Austria 421
HALLIDAY, A.N. *See* HAUGHTON, P.D.W.
HARBURY, N.A., JONES, M.E., AUDLEY-CHARLES, M.G., METCALFE, I. & MOHAMED, K.R. Structural evolution of Mesozoic Peninsular Malaysia 11
HARDMAN, M. *See* LEEDER, M.
HARMS, U., SCHANDELMEIER, H. & DARBYSHIRE, D.P.F. Pan-African reworked early/middle Proterozoic crust in NE Africa west of the Nile: Sr and Nd isotope evidence 859
HARPER, D.A.T. & RYAN, P.D. Towards a statistical system for palaeontologists 935
HARRISON, T.M. *See* FINCH, A.A.
HARTLEY, A.J. *See* JOLLEY, E.J.
HAUGHTON, P.D.W., ROGERS, G. & HALLIDAY, A.N. Provenance of Lower Old Red Sandstone conglomerates, Se Kincardineshire: evidence for the timing of Caledonian terrane accretion in central Scotland 105
HAY, W.W., BARRON, E.J. & THOMPSON, S.L. Global atmospheric circulation experiments on an Earth with polar and tropical continents 749
____ Results of global atmospheric circulation experiments on an Earth with a meridional pole-to-pole continent 385
HENRY, D.J. *See* MUKASA, S.B.
HESSELBO, S.P., COE, A.L. & JENKYNS, H.C. Recognition and documentation of depositional sequences from outcrop: an example from the Aptian and Albian on the eastern margin of the Wessex Basin 549
HIGGINS, A.C. *See* EBDON, C.C.
HIRONS, S. *See* ROBERTS, B.
HILL, I.A. *See* WILLIAMS, C.A.
HUCK, I.W. *See* ROBERTS, A.M.

JAILLARD, E., SOLER, P., CARLIER, G. & MOURIER, T. Geodynamic evolution of the northern and central Andes during early to middle Mesozoic times: a Tethyan model 1009
JENKYNS, H.C. *See* HESSELBO, S.P
____ *See* WEEDON, G.P.
JEPPSSON, L. An oceanic model for lithological and faunal changes tested on the Silurian record 663
JOLLEY, E.J., TURNER, P., WILLIAMS, G.D., HARTLEY, A.J. & FLINT, S. Sedimentological response of an alluvial system to Neogene thrust tectonics, Atacama Desert, northern Chile 769
JONES, M.E. *See* HARBURY, N.A.

KAMINSKI, M. *See* CLOETINGH, S.
KARIG, D.E. & KOZLU, H. Late Palaeogene–Neogene evolution of the triple junction region near Maras, south-central Turkey 1023
KNOX, R.W. O'B. *See* MORTON, A.C.
KOOI, H. *See* CLOETINGH, S.
KOZLU, H. *See* KARIG, D.E.

LAMING, D.J.C. *See* MCCALL, G.J.H.
LEAKE, B.E. *Presidential address*: Granite magmas: their sources, initiation and consequences of emplacement 579
LEE, M.K., PHARAOH, T.C. & SOPER, N.J. Structural trends in central Britain from images of gravity and aeromagnetic fields 241
LEEDER, M., RAISWELL, R., AL-BIATTY, H., MCMAHON, A. & HARDMAN, M. Carboniferous stratigraphy, sedimentation and correlation of well 48/3-3 in the southern North Sea Basin: integrated use of palynology, natural gamma/sonic logs and carbon/sulphur geochemistry 287
____ *See* ALEXANDER, J.
LEHURAY, A.P. *See* DIXON, P.R.
LINDQVIST, J.E. Thrust-related metamorphism in basement windows of the central Scandinavian Caledonides 69
LOVELL, J.H., CRAMPIN, S. & SHEPHERD, T.J. Stress in the Earth's crust: the link between crustal fluids and extensive-dilatancy anisotropy 971

MCCALL, G.J.H. & LAMING, D.J.C. *Conference Report*: GEOHAZARDS NATURAL and man-made 879
MCCAVE, I.N. *See* WANG, H.
MCELROY, R., CATER, J., ROBERTS, I., PECKHAM, A. & BOND, M. The structure and stratigraphy of SE Zanskar, Ladakh Himalaya 989

McKie, T. Tidal and storm influenced sedimentation from a Cambrian transgressive passive margin sequence 785
McMahon, A. *See* Leeder, M.
Maltman, A.J. *See* Fitches, W.R.
Marshall, J.D. & Middleton, P.D. Changes in marine isotopic composition and the late Ordovician glaciation 1
Martinez, J. *See* Max, M.D.
Martinsen, O.J. & Bakken, B. Extensional and compressional zones in slumps and slides in the Namurian of County Clare, Ireland 153
Max, M.D., Barber, A.J. & Martinez, J. Terrane assemblage of the Leinster Massif, SE Ireland, during the Lower Palaeozoic 1035
Megson, J. *See* Donato, J.A.
Metcalfe, I. & Mohamed, K.R. Structural evolution of Mesozoic Peninsular Malaysia 11
____ *See* Harbury, N.A.
Middleton, P.D. *See* Marshall, J.D.
Miller, J.A. *See* Petford, N.
Mitchener, B.C. *See* Ebdon, C.C.
Mohamed, K.R. *See* Harbury, N.A.
Mohr, P. Late Caledonian dolerite sill from Sw Connacht, Ireland 1061
Molenaar, N. Calcite cementation in shallow marine Eocene sandstones and constraints of early diagenesis 759
Molyneux, S.G. Advances and problems in Ordovician palynology of England and Wales 615
Monson, B. *See* Parnell, J.
Morrison, C. *See* Roberts, B.
Morton, A.C. & Knox, R.W.O'B. Geochemistry of late Palaeocene and early Eocene tephras from the North Sea Basin 425
Mourier, T. *See* Jaillard, E.
Muir, R.J. *See* Fitches, W.R.
Mukasa, S.B. & Henry, D.J. The San Nicolás batholith of coastal Peru: early Palaeozoic continental arc or continental rift magmatism? 27
Murphy, J.B. *See* Doig, R.
Murphy, F.X. The Irish Variscides: a fold belt developed within a major surge zone 511

Nance, R.D. *See* Doig, R.
Neilson, J.E. Experimental investigation of controls on cementation in carbonates 949
Ngwenya, B.T. & Bailey, D.K. Kaluwe carbonatite, Zambia: an alternative to natrocarbonatite 213
Nordgulen, Ø. & Shouenberg, B. The Caledonian Heilhornet Pluton, north-central Norway: geological setting, radiometric age and implications for the Scandinavian Caledonides 439

Owen, A.W. *See* Funnell, B.M.
Owens, R.M. *See* Fortey, R.A.

Parnell, J., Monson, B. & Tosswill, R.J. Petrography of thoriferous hydrocarbon nodules in sandstones, and their significance for petroleum exploration 837
Parrish, J.T. *See* Spicer, R.A.
Parrish, R.R. *See* Searle, M.P.
Peckham, A. *See* McElroy, R.
Petford, N. & Miller, J.A. SLM confocal microscopy: an improved way of viewing fission tracks 217
Pharaoh, T.C. *See* Lee, M.K.
Pirrie, D. *Conference Report*: Sea level changes at active plate margins: processes and products 563
Platt, N.H. Basin evolution and fault reactivation in the western Cameros basin, Northern Spain 165
Potts, G.J. A palaeomagnetic study of recumbently folded and thermally metamorphosed Torridon Group sediments, Eishort anticline, Skye, scotland 999
Powell, D. & Glendinning, N.R. Late Caledonian extensional reactivation of a ductile thrust in NW Scotland 979
Price, J.D. *See* Roberts, A.M.

Raiswell, R. *See* Leeder, M.
Rasmussen, B. & Glover, J.E. The diagenetic and economic significance of composite grains of monazite and hydrocarbon in Western Australian arenites 843
Rasul, S.M. *See* Richardson, J.B.

REAVY, R.J. *See* FINCH, A.A.
REX, D.C. *See* SEARLE, M.P.
____ *See* TRELOAR, P.J.
RICHARDSON, J.B. & RASUL, S.M. Palynofacies in a late Silurian regressive sequence in the Welsh Borderland and Wales 675
____ *See* FANNING, U.
ROBERTS, A., YIELDING, G. & FREEMAN, B. *Conference Report*: The geometry of normal faults 185
ROBERTS, A.M., BADLEY, M.E., PRICE, J.D. & HUCK, I.W. The structural history of a transtensional basin: Inner Moray Firth, NE Scotland 87
ROBERTS, B., MORRISON, C. & HIRONS, S. Low grade metamorphism of the Manx Group, Isle of Man: a comparative study of white mica 'crystallinity' techniques 271
ROBERTS, I. *See* MCELROY, R.
ROBERTSON, A.H.F. *See* CLIFT, P.D.
ROGERS, D.A. Probable tetrapod tracks rediscovered in the Devonian of N Scotland 746
ROGERS, G. *See* HAUGHTON, P.D.W.
RUFFELL, A. *See* SIMMS, M.J.
RUFFELL, A.H. *See* WIGNALL, P.B.
RUSHTON, A.W.A. Ordovician graptolite biostratigraphy in the Welsh Basin: a review 611
RYAN, P.D. *See* HARPER, D.A.T.
RYE, D.M. *See* DIXON, P.R.

SADLER, P.M. & STRAUSS, D.J. Estimation of completeness of stratigraphical sections using empirical data and theoretical models 471
SCHANDELMEIER, H. *See* HARMS, U.
SEARL, A. & FALLICK, A.E. Dinantian dolomites from East Fife: hydrothermal overprinting of early mixing-zone stable isotopic and Fe/mn compositions 623
SEARLE, M.P., PARRISH, R.R., TIRRUL, R. & REX, D.C. Age of crystallization of the K2 gneiss in the Baltoro Karakoram 603
SHEPHERD, T.J. *See* LOVELL, J.H.
SHOUENBERG, B. *See* NORDGULEN, Ø.
SIMMS, M.J. & RUFFELL, A. Climatic and biotic change in the late Triassic 321
SIVETER, D.J. *See* BASSETT, M.G.
SKJERLIE, K.P. *See* ANDERSEN, T.B.
SLOAN, R.J. & BENNETT, M.C. Geochemical character of Silurian volcanism in SW Ireland 1051
SMITH, D.G. Introduction: The nature and analysis of the stratigraphic record 469
SMITH, M.P. *See* BRYANT, I.D.
SNYDER, D.B. The Moine Thrust in the BIRPS data set 81
SOLER, P. *See* JAILLARD, E.
SOPER, N.J. *See* LEE, M.K.
SPARKS, R.S.J. *See* BRANNEY, M.J.
SPICER, R.A. & PARRISH, J.T. Late Cretaceous–early Tertiary palaeo-climates of northern high latitudes: a quantitative view 329
STOREY, B.C. *See* ALABASTER, T.
STRANK, A.R.E. *See* EBDON, C.C.
STRAUSS, D.J. *See* SADLER, P.M.
SUMMERHAYES, C.P. Introduction: Palaeoclimates 315
SWAN, A.R.H. A computer simulation of evolution by natural selection 223

TANNER, P.W.G. Structural age of the Connemara gabbros, western Ireland 599
THIRLWALL, M.F. & BURNARD, P. Pb-Sr-Nd isotope and chemical studies of the origin of undersaturated and over-saturated shoshonitic magmas from the Borralan pluton, Assynt, Nw Scotland 259
THOMPSON, S.L. *See* HAY, W.W.
THOROGOOD, E.J. Provenance of the pre-Devonian sediments of England and Wales: Sm-Nd isotopic evidence 591
TIPPER, J.C. Correlation in mosaic environments 487
TIRRUL, R. *See* SEARLE, M.P.
TORRENS, H.S. The scientific ancestry and historiography of *The Silurian System* 657
TOSSWILL, R.J. *See* PARNELL, J.

TRELOAR, P.J. & REX, D.C. Post-metamorphic cooling history of the Indian plate crystalline thrust stack, Pakistan Himalaya 735
TUFFNELL, P.A. *See* CHATTERTON, B.D.E.
TURNER, J.P. Structural and stratigraphic evolution of the West Jaca thrust-top basin, Spanish Pyrenees 177
TURNER, P. *See* JOLLEY, E.J.

WANG, H. & MCCAVE, I.N. Distinguishing climatic and current effects in mid-Pleistocene sediments of Hatton and Gardar Drifts, NE Atlantic 373
WATERS, C.N. The Cenozoic tectonic evolution of Alpine Corsica 811
WEEDON, G.P. & JENKYNS, H.C. Regular and irregular climatic cycles and the Belemnite Marls (Pliensbachian, Lower Jurassic, Wessex Basin) 915
WEISSERT, H. *See* FRÜH-GREEN, G.
WHITE, R.S. *See* WILLIAMS, C.A.
WIGNALL, P.B. & RUFFELL, A.H. The influence of a sudden climatic change on marine deposition in the Kimmeridgian of northwest Europe 365
WILLIAMS, C.A. HILL, I.A., YOUNG, R. & WHITE, R.S. Fracture zones across the Cape Verde Rise, NE Atlantic 851
WILLIAMS, G.D. *See* JOLLEY, E.J.
WOODCOCK, N.H. Sequence stratigraphy of the Palaeozoic Welsh Basin 537
____ *See* DIMBERLINE, A.J.
WRIGHT, V.P. Equatorial aridity and climatic oscillations during the early Carboniferous, southern Britain 359
____ & ALONSO ZARZA, A.M. Pedostratigraphic models for alluvial fan deposits: a tool for interpreting ancient sequences 8

YIELDING, G. FOOTWALL uplift associated with Late Jurassic normal faulting in the northern North Sea 219
____ *See* ROBERTS, A.
YOUNG, R. *See* WILLIAMS, C.A.

ZALASIEWICZ, J.A. Silurian graptolite biostratigraphy in the Welsh Basin 619

Proceedings

ANNUAL GENERAL MEETING
7 June 1989: Election of Officers and Council and presentation of Medals, Funds, Awards and Prize 195
ORDINARY GENERAL MEETING
23 February 1989: Lyell Meeting: Palaeoclimates 191
19 April 1989: William Smith Lecture Meeting: Origin of Petroleum: Basin evolution and modelling 193
GEOLOGICAL SOCIETY CHRISTMAS LECTURE
28 December 1989: Diverse worlds? 1100
GEOLOGICAL SOCIETY REVIEW SEMINAR
10 March 1989: Mineral deposit models 191
BRITISH GEOMORPHOLOGICAL RESEARCH GROUP
3–5 January 1989: (at Institute of British Geographers' conference) Soil erosion on agricultural land 188
25–26 May 1989: 11th Postgraduate symposium 194
22–24 September 1989: Annual meeting: Cold climate geomorphology 1094
20–22 November 1989: (with Natural Environmental Research Council)
Research student workshop 1097
BRITISH SEDIMENTOLOGICAL RESEARCH GROUP
10 March 1989: Reef sedimentation and diagenesis 191
8–21 April 1989: Field excursion to southern USA: Modern and ancient carbonates 192
12–14 April 1989: Workshop: Fluvial stratigraphy 193
20–21 April: Theoretical aspects and practical applications of cathodoluminescence in diagenesis 193
6 May 1989: Workshop: Palaeosols in siliciclastic sequences 193
9–11 May 1989: (with Joint Association for Geophysics) Sea level changes at active plate margins 193
17–18 May 1989: (with Marine Studies Group) Modern and ancient shelf anoxia 194
29–30 June 1989: (with Petroleum Group) Developments in sedimentary provenance studies 207
19–20 December 1989: Annual General Meeting 1099
COAL GEOLOGY GROUP
30 March 1989: Inaugural meeting 192
3 June 1989: Field meeting, East Midlands 195
5 October 1989: Workshop (at British Geological Survey, Keyworth) Recent advances in coal geology 1096
ENGINEERING GROUP
10 January 1989: (with Institution of Highways and Transportation) Recent examplesof earth retaining structures in highway schemes 189
7 February 1989: (with British Geotechnical Society) Deep excavations in soft rocks and overconsolidated clays 190
7 March 1989: Military aspects of engineering geology 191
14–16 April 1989: Field weekend: The SERC experimental slope failure project at Selbourne, Hampshire 193
16 May 1989: (with Joint Association for Geophysics and Society for Earthquake and Civil Engineering Dynamics) 194
10 October 1989: (with Hydrogeology Group) Groundwater control 1096
GEOLOGICAL CURATORS' GROUP
9 March 1989: The great sea dragons 191
7–8 June 1989: Geology and a local museum 206
6–7 September 1989: Field meeting and seminar: What price the 1990 orogeny? 1093
14 December 1989: AGM: Facets of our glittering heritage 1099
GEOLOGICAL INFORMATION GROUP
26 April 1989: Computer applications by young researchers 193
24 October 1989: Macintosh microcomputer laboratory 1096
21 December 1989: Imaging applications in geology 1100
HYDROGEOLOGY GROUP
17 April 1989: (with Joint Association of Geoscientists for International Development) The hydrogeology of crystalline basement aquifers in Africa 193
4 July 1989: Groundwater recharge estimation - any advances since 1979? 1093
10 October 1989: (with Engineering Group) Groundwater control 1096
HYDROLOGY GROUP
24 January 1989: Applications of remote sensing and airborne geophysics to hydrology 190
JOINT ASSOCIATION FOR GEOPHYSICS
10 February 1989: (at Royal Astronomical 'G' discussion meeting) Early heat sources in the Solar System 190

1 March 1989: Extensive-dilatancy anisotropy (EDA): using shearwaves to predict earthquakes 191
29–31 March 1989: (at UK Geophysical Assembly) 192
19 April 1989: Geophysics and the extractive industry 193
9–11 May 1989: (with British Sedimentological Research Group) Sea level changes at active plate margins 193
10 May 1989: Teaching geophysics to earth science undergraduates 193
16 May 1989: (with Engineering Group and Society for Eathquake and Civil Engineering Dynamics) 194
21 June 1989: EDA: The use of shear-waves to monitor the internal structure of reservoirs 207
27–28 September 1989: (at British Geological Survey, Keyworth) Image analysis and computer graphics in the display and interpretation of geophysical data 1095
25 October 1989: Shallow seismic reflection - where are we now? 1096
28–30 October 1989: Deep geology and geophysics of Ireland and its continental margin 1096
6 November 1989: The geoid in geophysics 1097

Joint Association of Geoscientists for International Development
17 April 1989: (with Hydrogeology Group) The hydrogeology of crystalline basement aquifers in Africa 193

Joint Association for Quaternary Research
4-5 January 1989: Discussion meeting 189
30 March-4 April 1989: Study course: Use of the scanning electron microscope in Quaternary sedimentology 192
4–7 April 1989: Annual Field Meeting: The West Midlands 192
12–14 April 1989: Discussion meeting: Environmental change in Iceland past and present 192
13–15 May 1989: Field meeting: Glen Roy and Lochaber 194
3–5 July 1989: (with Quaternary Research Association and Royal Society of Edinburgh) Late Cenozoic ice age 1093

Marine Studies Group
1 February 1989: GLORIA: The second decade 190
16–18 March 1989: Glacimarine environments processes and sediments 192
17–18 May 1989: (with British Sedimentological Research Group) Modern and ancient shelf anoxia 194
7–8 September 1989: Ocean drilling program – downhole measurements workshop 1094

Metamorphic Studies Group
8 March 1989: Research in progress 191
19–20 December 1989: Stability of minerals – geothermometry and geobarometry 1099

Mineral Deposits Studies Group
11–12 December 1989: Mineral deposits of Europe 1097

Petroleum Group
18 January 1989: Evening meeting 189
19 January 1989: Petroleum geology and geophysics research in academia 189
16 February 1989: (with Volcanic Studies Group) Relationship between magmatism and sedimentary basin evolution 190
14–15 March 1989: Geology from seismic data 192
21–23 May 1989: Tectonic events responsible for Britain's oil and gas reserves 194
14–15 June 1989: (with Tectonic Studies Group) Geometry of normal faults 206
29–30 June 1989: (with British Sedimentological Research Group) Developments in sedimentary provenance studies 207
14–15 September 1989: Petroleum migration 1094

Students' Open Day
23 November 1989: 1097

Tectonic Studies Group
4–5 March 1989: Moine–Dalradian workshop 191
29–31 March 1989: Deformation mechanisms, rheology and tectonics 192
6–10 June 1989: International workshop, Boppard/Rhein, West Germany: Rhenohercynian and Subvariscan fold belts 195
14–15 June 1989: (with Petroleum Group) Geometry of normal faults 206
18–20 December 1989: Annual General Meeting 1099

Volcanic Studies Group
16 February 1989: (with Petroleum Group) Relationship between magmatism and sedimentary basin evolution 190
22 February 1989: Volcanological research in progress 190

20–24 May 1989: Field Seminar: Tertiary igneous geology of Rhum 194

Conference Reports

DROOP, G.T.R. Metamorphic studies: research in progress 561
FUNNELL, B.M. & OWEN, A.W. Palaeocomputing: keyboard to the past 393
MCCALL, G.J.H. & LAMING, D.J.C. Geohazards natural and man made 879
PIRRIE, D. Sea level changes at active plate margins: processes and products 563
ROBERTS, A., YIELDING, G. & FREEMAN, B. The geometry of normal faults 185

Discussions on previously published papers

A model for the development of the Irish Variscides [E.A. WILLIAMS, M. FORD & H.E. EDWARDS: *reply by:* C.A. PRICE & S.P. TODD] *566*
A new palaeogeographic reconstruction for the Middle Jurassic of the northern North Sea [L.M. FÄLT & R.J. STEEL; reply by P.C. RICHARDS, S. BROWN, J.M. DEAN & R. ANDERTON] 1085
A reappraisal of the facing confrontation in north Cornwall: fold- or thrust-dominated tectonics [L.N. WARR & B. DURNING; *reply by* J.R. ANDREWS, C.F. PAMPLIN & A.J. BARKER] 408
Crustal structure of the Goban Spur continental margin, Northeast atlantic, from deep seismic reflection profiling [R.S. WHITE *reply by* C. PEDDY] 892
Dalradian slides and basin development: a radical reinterpretation of stratigraphy and structure in the Sw and Central Highlands of Scotland [J.L. ROBERTS & J.E. TREAGUS] 729
Detrital mineral ages from the Southern Uplands using ^{40}Ar-^{39}Ar laser probe [C. ELDERS, P. STONE & J.D. FLOYD; *reply by* S. KELLEY & B.J. BLUCK] 882
Genetic studies of red bed mineralization in the Triassic of the Cheshire Basin, northwest England [E.G POOLE; *reply by* P. TURNER & H. NAYLOR] 1091
Kinematics of the Alpine arc [L. RATSCHBACHER; *reply by* N. FRY] 572
Late Precambrian tidal rhythmites in South Australia and the history of the Earth's rotation [A.W. ARCHER, E.P. KVALE & H.R. JOHNSON; *reply by* G.E. WILLIAMS] 401
Late Precambrian tidal rhythmites in South Australia and the history of the Earth's rotation [F-L. DEUBNER] 1083
Palaeomagnetism, magnetic fabrics and the structural style of the Hornelen Old Red Sandstone, Western Norway [M.G. NORTON, W.J. WILKS, S.J. CUTHBERT & M. SÉRRANE; *reply by* R.H. TORSVIK, B.A. STURT, D.M. RAMSAY, D. BERING & P.R. FLUGE] 411
Swaley cross-stratification produced by unidirectional flows, Bencliff Grit (Upper Jurassic), Dorset, UK [S.Q. SUN & B.S. HART; *reply by* P.A. ALLEN & J.R. UNDERHILL] 396
The Grampian Group: a major Late Proterozoic clastic sequence in the Central Highlands of Scotland [P.J. HASELOCK & R.H.S. EVANS; *reply by* B.W. GLOVER & J.A. WINCHESTER 732
The palaeocurrent evidence of a northern structural high to the Welsh basin during the Late Llandovery [D.K. LOYDELL, R. CAVE, B.A.HAINS, D.M.D. JAMES & R.D.A. SMITH; *reply by* T. MCCANN & K.T. PICKERING 885

ERRATA

147, p. 1063, In the redrafting of Fig. 3, the compass direction was left unchanged and is thus wrong. The arrow points south in the direction of younging in near-vertical strata.

147, p. 1065, Table 3, for samples nos 30 and 31 read 28 and 29 respectively.

Referees for papers submitted in 1990

The following referees are thanked for their reports on scripts submitted for publication in the *Journal*.

S. M. Agar
T. Alabaster
J. Alexander
J. Ali
J. R. L. Allen
P. Allen
J. E. Andrews
H. Armstrong
W. Ashcroft
M. P. Atherton
H. Balkwill
R. Banks
R. G. C. Bathurst
P.O. Baumgartner
R. D. Beckinsale
M. Benton
S. Berhe
R. E. Bevins
M. J. Bickle
B. J. Bluck
D. Q. Bowen
C. J. R. Braithwaite
T. Brewer
D. Briggs
C. Bristow
M. Brooks
J. P. Burg
C. J. Carlon
A. C. Cattell
R. A. Chadwick
A. D. Chambers
J. Clack
E. N. K. Clarkson
J. D. Clements
R. A. Cliff
D. W. Coller
D. Cook
G. C. Coope
M. P. Coward
K. G. Cox
R. S. D'Lemos
J. S. Daly
G. A. Day
W. Dean
F. Debon
T. J. Dempster
J. F. Dewey
J. E. Dixon
T. Druitt
R. Duck
A. M. Duncan
C. Ebinger
T. Emmett
J. Esmonde-Cleary
J. Esson
C. D. R. Evans
J. A. Evans
D. J. Fairchild
D. Fettes
W. R. Fitches
P. A. Floyd
M. Ford
T. D. Ford
R. A. Fortey
M. Fowler
E. H. Francis
C. R. L. Friend
P. F. Friend
N. Fry
A. Gale
I. G. Gass
R. Gawthorpe
R. A. Gayer
F. Gibb
W. Gibbons
R. Goldring
B. Gomez
J. P. Gratier
J. Grocott
J. Hall
R. P. Hall
J. M. Hancock
R. Harmon
D. A. T. Harper
C. J. H. Hartnaday
C. J. Hawkesworth
S. Hesselbo
I. A. Hill
R. G. Hipkin
A. Hirn
R. E. Holdsworth
M. R. House
M. F. Howells
H. Huhma
A. Hurst
J. Hurst
D. H. W. Hutton
V. R. S. Hutton
H. C. Jenkyns
M. R. W. Johnson
E. J. Jolley
M. Juliverts
C. E. Keen
S. Kelley
J. W. Kennedy
D. V. Kent
R. Key
M. A. Khan
C. R. J. Kilburn
C. King
B. P. Kokelaar
S. D. Lake
S. Laux
R. C. Leake
M. K. Lee
M. Leeder
P. Lightfoot
R. Lisle
I. Livingstone
F. McDermott
R. MacDonald
D. G. Masson
J. B. Megson
I. Meighan
R. J. Merriman
R. Metcalfe
A. Miall
J Miller
A. R. Milner
N. J. Milton
K. Mitchell
D. J. Morgan
T. Morris
A. C. Morton
A. B. Moyes
R. Murray
D. Naylor
W. Nemec
G. Nichols
T. F. D. Nielson
S. R. Noble
M. Oczlon
G. Oliver
H. Pantin
R. G. Park
A. Perez-Estaun
E. A. Pessagno
J. S. Petwick
J. J. Peucat
T. C. Pharaoh
J. Philip
M. Piasecki
B. Pinet
H. Pinkerton
J. Piper
J. P. Platt
N. Platt
H. N. A. Priem
D. R. Prothero
C. J. Pudsey
A. Pulham
R. Raiswell
P. F. Rawson
H. Reading
A. J. Reedman
K. J. Reutter
A. Ribiero
R. J. Rice
A. M. Roberts
B. Roberts
A. H. F. Robertson
G. Rogers
D. A. Rothery
E. H. Rutter
D. J. Sanderson
T. J. O. Sanderson
A. D. Saunders
R. J. G. Savage
U. Scharer
P. Scott
S. Scott
A. Searl
M. P. Searle
I. Selby
J. Shennan
O. J. Simon
J. Smewing
A. Smith
A. G. Smith
D. G. Smith
D. K Smythe
R. Steel
E. Stephens
C. J. Stillman
P. Stone
D. A. V. Stow
F. Surlyk
A. R. H. Swan
P. N. Taylor
R. S. Thorpe
P. M. Traynor
A. Trench
B. R. Turner
P. Turner
B. G. J. Upton
F. J. Vine
G. Wadge
G. M. Walkenden
G. P. L. Walker
M. Warner
D. Waters
M. Watson
P. Webb
G. K. Westbrook
N. J. White
R. B. Whitmarsh
M. Widdowson
B. H. Wilkinson
M. Wilks
G. D. Williams
J. A. Winchester
B. F. Windley
N. H. Woodcock
B. Yardley
G. Yielding
P. K. Zeitler
N. J. Zinsmeister